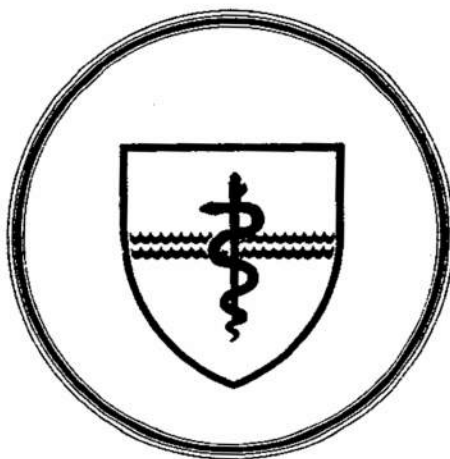# NAVAL SUBMARINE MEDICAL RESEARCH LABORATORY

SUBMARINE BASE, GROTON, CONN.

REPORT NUMBER 1080

PREDICTION OF NUCLEAR SUBMARINER ADAPTABILITY
FROM AUTONOMIC INDICES AND RORSCHACH INKBLOT RESPONSES

by

Benjamin B. Weybrew
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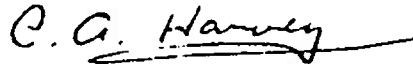Benjamin B. Weybrew
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THE PROBLEM

To assess the validity of selected indices of autonomic nervous system (ANS) function as well as responses to the Rorschach Inkblot Test for the prediction of submariners' adaptability to the conditions existing during long missions.

FINDINGS

Delineated by factor analysis, two Rorschach dimensions were found, one of which correlated significantly with three adaptability criterion axes. Two unique factors were also discovered, one a diffusely-structured ANS factor, and the other a complex, generalized criterion dimension. Taken together, these findings suggest that selected Rorschach indicants, and, to a lesser extent, certain ANS indices may have useful validity as predictors of submariner adaptability.

APPLICATIONS

Most nuclear submariners adapt well to the conditions existing during missions of 60 or more days duration. Others do not adapt adequately. The results of this factor analytical study suggest that a submariner's responses to the Rorschach Inkblot Test as well as his ANS patterns of reactivity to experimentally-induced stress may be significantly predictive of his capacity to adapt to submerged conditions.

ADMINISTRATIVE INFORMATION

ABSTRACT

To identify the most valid predictors of submariner adaptability, the authors derived 23 indices from the responses of 170 nuclear submariners to the Rorschach Inkblot Test, 11 measures of Autonomic Nervous System (ANS) reactivity to contrived stress, and five adjustment criteria. Factor analysis of this 39x39 correlation matrix yielded two Rorschach Factors, one of which correlated with three criterion dimensions. Two unique factors were also discovered, one, a structured ANS factor, and the other, a complex criterion scale. Selected Rorschach scores and, to a lesser extent, certain ANS indices emanating from this study, may be usefully-valid predictors of the adaptability of nuclear submariners during long patrols.

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PREDICTION OF NUCLEAR SUBMARINER ADAPTABILITY FROM
AUTONOMIC INDICES AND RORSCHACH INKBLOT RESPONSES
Benjamin B. Weybrew Ph.D.*
and
H. Barry Molish Ph.D.*

Since the Nautilus, the first automic-powered submarine, was
launched in 1954, there has been a focussed effort to identify
valid predictors of the quality of adaptation of nuclear
submariners to long submerged missions often exceeding 80 days.
A review of the literature of submarine psychology in the sixties
indicated that selected biographical, aptitude and objective
personality test scores yielded low but non-chance correlations
with officer's adjustment ratings of enlisted men[1]. However, the
same source indicated that there was a hiatus in the submarine
literature in that the use of projective techniques such as the
Rorschach Inkblot procedure for psychological prediction in this
context has not been thoroughly explored. Moreover, data were
presented to suggest that peripheral indices of autonomic nervous
system (ANS) reactivity and resiliency may be valid predictors of
maladaptive emotional reactions of submariners at sea (op.cit.).
Finally it was argued in the same review that the methodological
possibilities of multivariate analytical techniques such as
factor analysis applied to the submariner assessment problem had
not been given sufficient field testing.

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In a sense then the objectives of this paper were to follow through on the three recommendations presented in the 1963 review mentioned above which, to reiterate, were: to evaluate the Rorschach technique as a means of identifying predictors of nuclear submariner adaptability, to determine the validity of measures of ANS reactivity for the same purpose, and, finally, to ascertain the methodological possibilities of factor analysis in this context.

But there is not a complete absence of studies of this kind in the literature of submarine psychology. For example, one somewhat antiquated study provided the background for the present study[2]. Completed in the early fifties but not reported until the early sixties, this voluminous factor analytical study involved 180 variables including 18 Rorschach measures and 16 endocrinological and biochemical indices, some of which were known correlates of ANS reactivity. The subject sample consisted of 88 enlisted candidates for the diesel submarine service. While some additional information regarding the factor structures identified in this 1950 study will be discussed later, suffice to say that a Rorschach "Productivity" factor, marked mainly by high loadings by "R" (the total number of percepts reported on the 10 inkblot cards), and an endocrine function factor, loaded mainly by measures of urinary 17-ketosteroids, were two of the major factors isolated in this study.

In brief, the present study parallels certain aspects of the above submariner investigation. However, instead of a subject sample drawn from enlisted recruits for the diesel submarine

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service, the data for the present study were collected entirely from nuclear submariners. All of the data for this study was collected in the sixties from both enlisted crews of one nuclear-powered, Fleet Ballistic Missile (FBM) submarine. The tests were administered during the three months retraining period to the gold crew while the blue crew was on station and vice versa.

METHODS

Subjects

The subject sample consisted of 85 male enlisted nuclear submariners from each of the Blue and Gold crews of one FBM submarine. Their age ranged between 18 and 45 years with a mean of 27 years. The mean General Classification Test (GCT) score for the distributions of both crews was approximately 59 (S.D.=8). This mean was approximately equivalent to the 81st percentile for the U.S. Navy enlisted population as a whole. Since both the distributions of test scores and biographical data for the two crews were not significantly different, they were pooled, the end result being a composite sample of 170 for inclusion in the factor analysis to follow.

Procedure

The standardized, 10-card form of the Rorschach Inkblot Test was individually administered and hand scored by the second author, using a modified version of the Beck Scoring system[3]. Since most of the 23 Rorschach measures involved simple response frequency counts which characteristically yield Poisson*

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*Poisson distribution--a skewed probability distribution.

distributions, it became necessary to reduce and stabilize the correlation between the means and variances typically found in distributions of this kind. Recommended for this purpose was the Freeman-Tukey square root tranformation which was applied to all of the Rorschach scores derived from response frequency counts[4].

Table I contains the means and SDs as well as a brief statement describing the scoring procedure for each of the Rorschach measures. These include eight measures of Location (scores numbered 1 through 6 and 14 and 21 in Table I), five Determinant indices (Z, C, F+%, Zf, and M--Nos. 8, 10, 13, 22, and 23, respectively), three measures of Response Style, E.B., Afr, and L (Nos. 9, 15, and 16), and two measures of Content, A% and P (Nos. 11 and 12). Productivity was measured by total number of percepts (R, No. 7), while the remaining four scores (Nos. 17, 18, 19, 20) were measures of response rate and latency.

Brief statements describing the 16 ANS and criterion measures included in the 39-variable factor analysis are contained in Table II.

The five adjustment criteria consisted of factor scores obtained from a separate factor analysis of rating data collected from the same two submarine crews during two successive submerged missions of 60 days duration. These factor scores for each subject on each criterion dimension (Nos. 24-28 in Table II) were derived by summing the Z-scores* weighted by the factor loadings

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*Not to be confused with the Rorschach Z-score (No. 8 in Table I), this Z-score is a linearly-transformed, standard score, the distribution for which has a mean of 50 and a SD of 10.

Table I

Scoring Procedures and Means and SDs for the 23

Rorschach Variables (N=170 Nuclear Submariners)

	Symbol	Score Content	Computational Procedures	Mean	S.D.
1	W	Whole Card Response	Number of W Responses(R)	4.9	4.0
2	D	Major Detail	Number of Responses	16.7	8.2
3	Dd	Rare Detail	Number of Responses	1.6	1.3
4	Ws	Whole Response with S Component	Number of Responses	0.6	0.4
5	Ds	White Space, Major Detail	Number of Responses	1.6	1.0
6	Dds	White Space, Rare Detail	Number of Responses	0.5	0.2
7	R	Total Responses	Σ of Responses to 10 Cards	24.8	11.1
8	Z	Synthesized Percepts	Σ of Weighted Z Scores on 10 Cards	22.4	14.7
9	EB	Experience Balance	M/C_{sum}	1.2	1.0
10	C_{sum}	Undiluted Color Determinant	Σ of all C Values	3.1	2.3
11	A%	Animal Content	Percentage of Total R	50.5	13.7
12	P	Popular Response	Total Number Responses	6.2	2.2
13	F+%	Superior Form Ratio	F+/ΣF+ and F- (percent)	78.4	12.8
14	S	White Space	Number S-Determinant R's	1.9	1.3
15	Afr	Affective Ratio	Ratio of R's Cards 8-10/ R's Cards 1-7	0.7	0.6
16	L	Lambda Index	Ratio of F Responses to non-F Responses	3.4	3.1
17	T/R	Response Time	Average Time (T) per R (seconds)	34.2	15.3
18	T/1st R	First Response Latency	Average T/1st R over 10 Cards (seconds)	22.4	11.6
19	Fln R	Fluctuation of R's Between Cards	Average Differences Between R's/ Card	1.2	0.9
20	Fln T/ 1st R	Fluctuation of T/1st R	Average Difference Between T/1st R per Card	17.3	10.4
21	S%	Relative Number White Space R	Percentage White Space Responses	6.8	6.2
22	Zf	Form-Determined Organizational Activity	Σ unweighted Z responses	8.1	4.5
23	M	Movement Responses	Number of M Responses	1.8	1.3

Table II

Scoring Procedures and Means and SD's for the 11

Autonomic Indices and Five Submariner Adjustment Criteria (N=170)

No.	Symbol	Score Content	Computational Procedures	Mean	S.D.
24	F-I[*]	Favorable Adjustment I	Factor Scores, 12 Ratings	225.1	100.2
25	F-II	Favorable Adjustment II	Factor Scores, 12 Ratings	446.8	329.8
26	F-III	Poor Military Behavior	Factor Scores, 3 Ratings	73.3	50.7
27	F-IV	Good Military Behavior	Factor Scores, 3 Ratings	66.3	22.1
28	F-V	Leadership Potential	Factor Scores, 3 Ratings	69.8	55.2
29	ARI	Autonomic Rebound Index	EDC[**] Recovery Rate	25.3	24.5
30	BL	EDC Basal Level	Average Resting EDC Level	83.9	27.6
31	BL-AD	Fluctuation of Basal EDC	Average Deviation of Basal EDC	85.0	63.3
32	Con EDC-Max	GSR[**] to Maximum Discrimination Conflict	Mean GSR's to Maximum Conflict	267.9	193.1
33	Con EDC Min	GSR to Minimum Discrimination (BH)	Mean GSR's to Minimum Conflict	239.8	165.6
34	BHRS	Breathholding (BH) Recovery Slope	Slope of EDC Curve During BH (degrees)	54.6	52.5
35	Hyp-BH/DI	EDC Displacement Index During Hyperventilation and BH	% EDC Change During Hyp/BH	26.8	5.2
36	Hyp-BH/DI	Recovery Index, Hyp/BH	% EDC Recovered After Hyp/BH	20.2	6.3
37	Hyp-BH/RQ	Recovery Quotient, Hyp/BH	R.Q.=RI/DI (to percent)	2.4	1.9
38	Con-RI	Recovery Index to Conflict	% of DI (Conflict) Recovered	1.2	0.7
39	Con-DI	Displacement Index to Conflict	% Change in EDC to Conflict	58.2	41.9

[*]See text and reference[5] for a description of the methodology used in deriving these five criterion scores.

[**]GSR-Galvanic Skin Response; EDC-electrodermal conductance, units are micromhos, after Freeman[7].

for the specific rating scales defining each of the 5 factors used as criteria. The rating scale battery consisted of the following 22 scales; 15 paired-comparison trait rating scales, 5 standard navy semi-annual performance scales, and 2 attitude-change measures. The content of the trait ratings included scales for emotional stability, leadership, interpersonal attitudes, etc. These are described in some detail elsewhere[56].

Numbered 29 through 39 in Table II, the ANS measures were derived from data that originated in two laboratory-contrived stress situations the methodology for which was developed and field-testing in another study[8]. The hyperventilation and breathholding (Hyp-BH) paradigm, designed to measure ANS reactivity and resiliency, consisted in asking each subject to take 4 deep breaths and to hold the fourth breath as long as possible. Electrodermal conductance (EDC) measures were taken continuously throughout the procedure. Seven scores, briefly described and numbered 29, 30, 31, 34, 35, 36, and 37 in Table II, were derived from this experiment (see reference eight for procedural details).

The second experimental paradigm, the Conflict (Con) induction procedure, consisted again of continuous EDC measurement while each subject was time-paced while making the decision as to the brighter of two lights which incrementally, trial-by-trial, were made increasingly more similar in terms of intensity (op.cit.). The "true" brighter light was randomized right or left during the 16 trial sessions. The four Conflict scores, numbered 32, 33, 38, and 39 in Table II, were derived

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from this procedure.

It is to be noted that the means and SDs for each of the 16 ANS variables are also included in Table II. Relevant aspects of these distribution statistics for each measure will be referred to in the discussion section.

Statistical Methodology

The 39x39 matrix of 741 Pearson Product Moment coefficients was factor analyzed by computer, using the Principal Components Method[9]. With communalities estimated by a reiterative method, this mathematically precise technique yields as many factors or principal components as variables; however, most of the variance is removed with the first few vectors extracted. The axes were rotated orthogonally by computer using the Varimax procedure, an analytical technique that mathematically closely achieves what factor analysts call the simple structure criterion[10][11].

RESULTS

The Correlation Matrix*

Of the 741 coefficients in the 39x39 matrix, 156 or 21 percent were significant at the 5% or less confidence level**. Both the intercorrelations of the Rorschach scores (253 coefficients, r's) and the ANS scores (55 r's) were remarkably high inasmuch as 66% of the former and 80% of the latter were

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*The bulky correlation matrix is not presented here; however, a copy may be obtained by request from the first author.

**"Significant" hereafter in this context means 5% or less confidence level.

significant. However, many of these high r's are considered spurious due to the linear dependencies inherent in the scoring systems for the two classes of variables. For example, A% and S% are percentages of the total number of Rorschach responses (R-score, No. 7 in Table I). Similarly, examples of ANS score interdependencies are found in variables numbered 35, 36, and 37 in Table II, wherein each score is directly proportionate to all others. Finally, very high inter r's are seen among the five adjustment criterion dimensions, (Nos. 24-28 in Table II), but this time the spuriously high coefficients are probably due in part to the halo effect, characteristically found in trait ratings of this kind.

It is important to note that only 6 (5%) of the 115 r's relating Rorschach scores to the 5 criteria reached significance. At the same time 12 (22%) of the 55 r's interrelating the ANS measures to the criteria were significant. Finally, only 2% (5 r's) between the Rorschach indices and the ANS measures reached significance.

Reverting back to the distribution statistics for the 39 variables in Tables I and II, the question arises as to the comparability of the score distributions of the nuclear submariner sample in this study with identical scores obtained from other population samples. Unfortunately, comparable normative data existed only for the Rorschach indices obtained from one civilian population sample, N=157[12] . The mean scores for only three of the 23 Rorschach measures in Table I differed significantly from the means of this comparison sample (5% level,

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t-test). Thus the FBM group (N=170) yielded lower total response

scores (R), lower movement scores (M), and lower isolated detail

scores (D), variable Nos. 7, 23, and 2, respectively (Table *).

Possible interpretations of these group differences will be

addressed in the discussion section to follow.

The Factor Matrix

In interpreting factors extracted by the Principal Components

Method it is generally considered that to be meaningful the

factors should have eigenvalues $\bar{>}$ unity*. Accordingly, only 12

of the total 39 principal components are presented in Table III.

Furthermore, because of a lack of clarity resulting from the

rotated solution, only four of these 12 factors, accounting for

more than half of the total variance, were considered

interpretable. Finally, in order to meaningfully discuss the

structure of these four factors, it was necessary to identify the

marker variables, i.e., the variables with the highest loadings

on each factor. These marker variables are listed and rank-

ordered for each of the four factors in Table IV**.

Consistent with the earlier factor analysis of Rorschach data

obtained from diesel submariners[2], we labelled the first factor

"Organized Productivity" since it was weighted heavily by R, Z,

and Zf scores, (nos. 7, 8, and 22 in that order in Tables III and

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*Eigenvalues are roots of equations which are solved in sets
from which the factors or, in geometric terms, vectors are
derived. For a comprehensive coverage of factor analytic
methodology, see[13] .

**Tables III and IV should be used in conjunction when
deducing the structure of each of the four factors.

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Table III

Rotated Factor Loadings for 23 Rorschach Indices,
13 Autonomic Measures, and Five Adjustment Criteria (N=170)

	Variables*	F_1	F_2	F_3	F_4	F_5	F_6	F_7	F_8	F_9	F_{10}	F_{11}	F_{12}
1	W	52**	-28	46	-19	15	19	32	-19	12	-13	-15	-04
2	D	60	-02	-11	16	-65	06	-10	08	08	05	10	06
3	Dd	33	06	-22	22	-54	09	-26	08	-21	-13	-19	16
4	Ws	46	-12	25	-30	29	-20	-21	-08	-03	12	09	-10
5	Ds	61	06	-13	09	11	-05	-52	06	14	-04	00	-08
6	DdS	32	-04	-15	-01	-11	-25	-25	18	-41	10	10	02
7	R	69	-07	-47	28	-23	02	-17	-06	06	03	-02	15
8	Z	77	-16	-13	06	45	01	19	-11	15	04	-08	-07
9	EB	27	-04	-39	-05	-05	01	31	55	-03	-04	13	-25
10	C$_{sum}$	50	-09	64	-14	-18	06	02	03	-01	-09	-08	34
11	A%	-27	07	-46	24	-04	06	-02	-24	24	18	05	-23
12	P	39	-03	-18	04	-40	11	30	15	14	09	20	-17
13	F+%	-26	-02	-57	13	30	-10	33	-05	03	01	09	17
14	S	71	00	08	-20	17	-22	-53	11	-05	08	12	-14
15	Afr	18	07	64	-23	-40	08	14	03	15	09	00	-19
16	L	-27	07	-19	04	-53	02	-19	-29	29	03	-01	-31
17	T/R	-67	08	-11	-07	38	00	-05	35	10	-04	-05	01
18	T/1st R	-51	09	37	-25	06	16	-13	46	17	10	-02	-05
19	Fln R	48	-02	-27	24	-26	02	-18	17	22	05	-22	08
20	Fln T/1st R	-52	05	08	-13	21	09	-23	48	31	07	-03	13
21	S%	50	03	06	-24	35	-27	-58	10	-05	07	14	-18
22	Zf	77	-21	-08	04	40	03	19	-15	23	00	-08	-09
23	M	44	-09	-24	05	-04	05	47	55	-11	00	12	-23
24	F-I	06	-19	29	59	-03	39	-01	06	29	00	-08	06
25	F-II	-08	-12	08	40	-01	21	-18	25	31	-32	-43	-06
26	F-III	-10	-12	42	-77	04	-32	05	05	-11	06	09	-10
27	F-IV	-15	-04	-42	73	06	30	06	02	-16	06	10	-12
28	F-V	06	27	-40	69	19	-07	09	00	-16	07	08	-12
29	ARI	13	64	-13	-11	-08	-40	14	05	04	-02	-10	00
30	BL	-05	-32	09	15	-02	32	-02	-02	11	48	21	25
31	BL-AD	18	60	-06	07	09	-01	-03	-12	-24	05	05	13
32	Con EDC-Max	04	45	-04	-26	-11	-70	18	00	09	-09	-02	13
33	Con EDC-Min	-11	09	-07	-40	-15	-75	14	-05	06	-05	01	09
34	BHRS	-04	09	01	-23	-20	-56	31	-07	01	28	-10	-08
35	Hyp-BHDI	18	92	12	03	04	13	04	02	07	00	02	-02
36	Hyp-BHRI	18	95	04	05	04	11	04	-01	07	05	-01	02
37	Byp-BHRQ	16	93	05	09	07	17	02	02	06	-01	-01	00
38	Con-RI	18	95	04	07	08	15	02	00	05	01	-01	02
39	Con-DI	12	89	08	12	09	19	01	-01	05	03	01	00
% Variance		18	16	9	9	7	7	6	5	3	2	2	1

*The symbols identifying the variables are explained in Tables I and II.
**Decimals are omitted.

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Table IV

Structural Characteristics of the Four Major Factors Extracted
from the 39 x 39 Rorschach, Autonomic and Criterion Matrix

Factor Number and Tentative Label	Marker Variables			Abstract of Factor Content
	Matrix Number	Variables*	Loading	
F_1 - Unique Rorschach Factor: Organized Productivity	8	Z	77**	With the exception of R, none of the mean Rorschach scores identifying F_1 is significantly different from the Beck norms. The highest factor loadings by Z and Zf together with a moderate loading of W suggest perceptual synthesizing processes and possibly an intellectual component. The positive loading of "R", with both T/R and Fln/T loading negative argue for a "productivity" element in F_1. The loadings of D and Ds suggest that persons earning a high score on this factor are well adjusted. Finally the loadings of S, S%, and C_{sum} may indicate a self-assertive, extrovertive personality component in the structure of F_1. F_1 accounted for 18% of the total variance, (Table III).
	22	Zf	77	
	14	S	71	
	7	R	69	
	17	T/R	-67	
	5	Ds	61	
	2	D	60	
	1	W	52	
	20	Fln/T	-52	
	18	T/1stR	-51	
	21	S%	50	
	10	C_{sum}	50	
F_2 - Unique Autonomic Factor: Autonomic Resiliency	36	Hyp-BHRI	95	This unique autonomic factor is characterized by large electrodermal conductance (EDC) changes to hyperventilation and breathholding and to conflict stress (Variables 35 and 39 in that order). Complete EDC recovery (36, 37, 38) and a high degree of EDC fluctuation in both baseline and post-stress data (37 and 29) also contribute significantly to the structure of this factor. As a whole, this ANS pattern suggests emotional stability based upon earlier findings in the submarine literature. F_2 accounted for 16% of the variance.
	38	Con-RI	95	
	37	Hyp-BHRQ	93	
	35	Hyp-BHDI	92	
	39	Con-DI	89	
	29	ARI	64	
	31	BL-AD	60	

Table IV (continued)

Factor Number and Tentative Label	Marker Variables			Abstract of Factor Content
	Matrix Number	Variables	Loading	
F$_3$ – Rorschach Affectivity Factor	10	C$_{sum}$	64	The positive loadings of C$_{sum}$ and Afr on F$_3$, taken together with the low but significant loading of M (Table III) suggest a strong affective component, implying impulsivity and extroversion. While the low positive loading of W indicates some synthesizing ability, the negative loadings of F+% and R may indicate a counteractive, inadequacy trend in productivity and form perception. Although the loadings are low, the fact that the negative criterion (No. 26) is loaded positive and two of the four positive criteria (27 and 28) are loaded negative suggests the likelihood that this affective dimension of the Rorschach is a useful predictor of inadequate submariner adjustment.
	15	Afr	64	
	13	F+%	-57	
	7	R	-47	
	11	A%	-46	
	1	W	46	
	26	F-III	42	
	27	F-IV	-42	
	28	F-V	-40	
F$_4$ – Favorable Submariner Adjustment	26	F-III	-77	F$_4$ is a unique factor whose structure is defined by the five adjustment criteria, the sign pattern being indicative of favorable submariner adjustment. Examples of the trait ratings included in the criterion factor scores are: The negative criterion (No. 26), poor military performance and emotional instability, and the positive criteria (24, 25, 27, 28) consisting of favorable performance, emotional stability, leadership ability, and favorable attitudes, in concert, tend to support the hypothesis that F$_4$ is a valid measure of nuclear adjustment. Too, the negative loading of Con-EDC-Min tends to further support this proposition. As noted in Table III, F$_3$ and F$_4$ each account for 9% of the total variance.
	27	F-IV	73	
	28	F-V	69	
	24	F-I	59	
	25	F-II	40	
	33	Con-EDC-Min	-40	

*The meaning of the variable symbols is contained in Tables I and II.
**Decimals are omitted.
+Abstracted from reference 5.

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IV). The abstract of the content of F_1 in Table IV describes a unique factor, identified wholly by a pattern of Rorschach indices. In this context it is important to note that F_1 contains no elements of either the ANS scores or the adjustment criteria since none of these variables (nos. 24-39 in Table III) load F_1 significantly.

Similarly, F_2 is a unique factor, defined entirely by significant factor weights for 7 of the 11 ANS measures, (Nos. 29-39 inclusive in Table III). It is seen in Table IV that F_2 is referred to as an "Autonomic Resiliency" factor, so labelled because the ANS indices with the highest weights or loadings on F_2 are dynamic as opposed to static, that is they measure EDC changes to, and recover from, stress induction rather than baseline levels[14] (see Table II and the methods section). Again, the absence of significant loadings by any of the Rorschach or criterion measures (Table III) attests to the uniqueness of this factor.

F_3 appears to be another Rorschach factor but somewhat different in structure from the first Rorschach factor (F_1) extracted in this analysis. In the first place, the total Rorschach response measure (R, No. 7 in Table III), loads F_1 positively but is negative on F_3. Thus submariners who give the most responses tend to obtain a higher factor score on F_1, the Productivity Factor, but at the same time a lower score on F_3. Secondly as the abstract in Table IV suggests, the major difference between F_1 and F_3 is that the latter is marked mainly by high positive loadings of color-determined percepts (C_{sum}, No.

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10, and Affective Ratio, No. 15). Together with a negative weight by M, movement responses, (No. 23 in Table IV), these two affectivity scores suggest a trait pattern characterized by emotionality directed outwardly*.

While labelled differently, Rorschach factors marked mainly by responses to the chromatic aspects of the Rorschach cards have been identified in other factor analytic studies. For example, one investigation which identified a "Productivity" factor, also found a factor called Unique Low Form Dominance[17]. This dimension was marked by high positive loadings by color responses and by negative loadings in form-determined responses, the latter marker variable being consistent with the loading on F_3 of -.57 for variable No. 13 (F+%) in Table IV.

In sum, since a Rorschach factor, identified largely by color-determined responses, was identified in at least four studies involving quite different population samples, some assurance can be gained that a "Rorschach Color Factor" does indeed exist. Moreover, when found in a given population, this factor presumably suggests the presence of some complex emotional trait dimension associated with significant extrovertive and impulsive tendencies. Also alluded to in the abstract of the content of F_3 in Table IV are the interrelated findings that criterion variable No. 26, shown to be indicative of unfavorable military performance[5,6], loaded positively on F_3. At the same time, the two favorable performance criteria (Nos. 27 and 28)

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*Factor-analytically derived patterns of Rorschach measures have also been used to describe classes of psychopathology[15,16].

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received negative weights on the same factor. Taken together, these findings suggest that the Rorschach Affectivity Factor (F_3) may be predictive of inadequate submariner performance underway. The proposition contained in Table IV that submariners who obtain a high score in F_3 also tend to possess strong extrovertive and impulsive traits appears to further support this predictive relationship since these traits tend to characterize a significant segment of those submariners who develop debilitative psychiatric symptoms at sea[18].

The configuration of factor loadings in Table IV presents the clear outline of F_4 as another unique factor defined almost entirely by the five criterion variables numbered 24 through 28. Thus a nuclear submariner will earn a high score on F_4 if his score on the negative criterion F-III (No. 26) is low and/or his scores on one or more of the positive dimensions (Nos. 24, 25, 27, 28) is high. That is, the higher the score on F_4 the more adequate the submariner's adjustment is likely to be.

DISCUSSION

Beginning with the establishment of the U.S. Naval Submarine Medical Research Laboratory at New London, Connecticut in 1946, the history of Submarine Psychology has shown periodic attempts to sift through masses of data in order to identify psychobiological dimensions usefully predictive of individual differences in submariner adaptive capacity[19]. The present study is one such exploratory, multivariate investigation designed to sort through several classes of potential predictors of nuclear

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submariner adaptability. As stated earlier, these data were collected in the sixties, and, as a result, the findings may not be applicable to the modern nuclear submariner population. However, there are data[20] suggesting that the distributions of submariner aptitude and personality test scores have remained relatively constant over the past 20 years or more. While largely speculation, these findings argue that were this study replicated at this time, essentially the same conclusions could be drawn from the data.

The interrelated findings that the nuclear submariners in the present sample obtained significantly lower Rorschach movement (M), major detail (D), and productivity(R) scores (Measure Nos. 23, 2 and 7, respectively in Table I) than did a comparable sample from the civilian sector should be mentioned. The lower productivity (R) of the submariners may have been the result of their interpretation of the Rorschach procedure as having low face validity for nuclear submariners, the end result being reduced motivation and hence low response scores. While low "R" scores are sometimes indicative of a lack of originality most often found in groups of average or below average ability[16], this would not seem to be the case in a superior ability group such as the present sample of nuclear submariners.

The lower average number of movement responses (M, No. 23 in Table I) found in the submariner group, particularly in the context of normal or slightly elevated C_{sum} (color-determined responses, No. 10 in Table I), suggests traits associated with less suppression of acting-out behavior, or, as described in the

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abstract for F_3 in Table IV may indicate trends toward impulsive and extrovertive behavior-much more at least than are found in the civilian sample used for comparison. Too, the negative factor loading (-.39) of Experience Balance (No. 9 in Table III) on F_3 would lend additional support for the presence of personality traits such as outgoingness and unrestraint as more-or-less characteristic of those submariners who earn a high score on this factor.

In terms of the major objective of this investigation, namely, to identify by factor analysis, clusters of valid predictors of submariner adaptability, what do the results indicate? Overall, the findings would seem more to suggest the classes of variables that are not likely to be useful predictors of submariner adjustment than to pinpoint those that have a high probability to be useful for that purpose. Thus F_1, a unique Rorschach factor, "Organized Productivity" (Table IV), as well as F_2, also a unique ANS factor labelled "Autonomic Resiliency", are uncorrelated with each other and neither is correlated with any of the adjustment criteria. These criteria in turn tend to cluster in still another unique factor, F_4, "Favorable Submariner adjustment" (Table IV).

There is considerable evidence in the literature of Submarine Psychology that measures of ANS reactivity and resiliency are generally correlated with submariner adaptability under most conditions[14]. Yet, F_2 whose main components were defined by ANS indices, was not related to any of the criteria (Tables III and IV). Why was this? One possible explanation is low reliability

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of the criterion dimensions themselves. Another reason has to do with the possible invalidity of ANS measures taken in shore-based, laboratory-contrived stress situations for predicting the adaptability of submariners during long submerged missions, during which time quite different environmental conditions would likely prevail.

How is the fact that the Rorschach factor (F_1), a dimension marked largely by Rorschach indices of functional intelligence and perceptual organizational ability (W, R, and Z, Nos. 1, 7, and 8 in that order in Table IV) does not correlate with any of the criteria, but that the other Rorschach factor (F_3), an affectivity dimension, does correlate with three of the criteria (Table IV)? The answer to this question suggests an hypothesis regarding the direction submariner assessment researchers might be advised to take. Because nuclear submariners are thoroughly screened in terms of a variety of abilities, the range of individual differences with this population i.e., the variance, is greatly reduced with regard to this particular trait area. As a result, the Rorschach indices W, R, and Z, which also "tap" certain aspects of the abilities domain, tend to be uncorrelated with any of the criteria largely because of this low variation. In contrast, the fact that F_3 whose major components are affective or emotional in nature, (at least as indicated by the Rorschach score pattern) does correlate negatively with three of the adjustment criteria would seem to argue that measures of temperament and emotionality may be usefully predictive of individual differences in the adaptive potential of nuclear

submariners during protracted submerged missions. This finding
may represent a meaningful cue as to the focus research in
submariner assessment should take in the future.

REFERENCES

1. Weybrew, B.B.: Psychological problems of prolonged periods of marine submergence. In Burns, N., Chambers, R. and Hendler, E. (Eds) Unusual Environments and Human Behavior Free Press, Glencoe, Ill., 1963.

2. Cook, E.B.: A factor analysis of personnel selection data: Intra- and inter-area relationships of biochemical, physiological, psychological and anthropometric measures. NavFieldMedRschLab XI (No. 26), 1961.

3. Beck, S.J.: Rorschach's Test I: Basic Processes. Grune and Stratton, New York, 1944.

4. Freeman, M.F., and J.W. Tukey: Tranformations related to the angular and the square root. Ann. Math. Statist., 1950: 21: 607-611.

5. Weybrew, B.B.: Prediction of adjustment to long submergence aboard an FBM submarine I. Interrelationship of the adjustment criteria. Nav. Sub. Med. Res Lab. Rept. No. 383, 1962.

6. Weybrew, B.B.: Prediction of adjustment to long submergence aboard an FBM submarine IV: Psychophysiological indices. Nav. Sub. Med. Res. Lab. Rpt. No. 416, 1964.

7. Freeman, G.L.: The energetics of human behavior. Cornell University Press, 1948.

8. Weybrew, B.B.: Behavioral energetics I. A factor analytical study of individual differences in modes of energy discharge resulting from experimentally-induced frustration. Nav. Sub. Med. Res. Lab. Rpt. No. 378, 1962.

9. Hotelling, H.: Analysis of a complex of statistical variables into principal components. J. educ. Psychol. 1933: 24: 417-441.

10. Kaiser, H.F.: The varimax criterion for analytic rotation in factor analysis. J. educ. Psychol. 1956:23:187-200.

11. Fructer, B.: Introduction to factor analysis. D. Van Nostrand and Co., Inc., New York, 1954.

12. Beck, S.J., A.I. Rabin, W.G. Thiesen, H.B. Molish, and W.N. Thetford: The normal personality as projected in the Rorschach test. J. Psychol. 1950:30:241-298.

13. Harman, H.H.: Modern Factor Analysis (2nd. ed.) University of Chicago Press, 1967.

14. Weybrew, B.B.: Selection of men for hazardous duty from indices of autonomic nervous system reactivity. Nav. Sub. Med. Res. Lab. Memorandum Rpt. No. 65-1, 1965.

15. Molish, H.B.: Schizophrenic reaction types in a naval hospital population as evaluted by the Rorschach test. U.S. N. Bureau Med. and Surgery Project No. NM. 007-089.31, Washington, D.C., 1957.

16. Rickers-Ovsiankina, M.: Rorschach Psychology. Wiley, New York, 1960.

17. Coan, R.: A factor analysis of Rorschach determinants. J. Proj. Tech. 1956:20:280-287.

18. Weybrew, B.B. and E.M. Noddin, Psychiatric aspects of the problem of adaptation to long submarine missions. Aviat. space and env. med. 1979:50:575-580.

19. Weybrew, B.B.: History of military psychology at the U.S. Naval Submarine Medical Research Laboratory. Nav. Sub. Med. Res. Lab. Rpt. No. 917, 1979.

20. Weybrew, B.B. and E.M. Noddin. The Longitudinal Health Study: Changes in the psychological characteristics of enlisted submariner volunteers over the past two decades. Nav. Sub. Med. Res. Lab. Rpt. No. 817, 1978.

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To identify the most valid predictors of submariner adaptability, the authors derived 23 indices from the responses of 170 nuclear submariners to the Rorschach Inkblot Test, 11 measures of Autonomic Nervous System (ANS) reactivity to contrived stress, and five adjustment criteria. Factor analysis of this 39 x 39 correlation matrix yielded two Rorschach Factors, one of which correlated with three criterion dimensions. Two unique factors were also discovered; one, a structured ANS factor, and the other, a complex criterion scale. Selected Rorschach scores and, to a lesser

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extent, certain ANS indices emanating from this study, may be usefully-valid predictors of the adaptability of nuclear submariners during long patrols.